2.3.5. Antenna Stabilization Limits

2.3.5.1. Purpose

The purpose of this test is to assess the ability of the radar antenna to maintain stabilization during maneuvering flight and to determine its effect upon intercept and attack utility.

2.3.5.2. General

As discussed earlier, many radar antennas are gyroscopically or inertially stabilized in relation to the horizon within the scan and elevation limits. Realistically; however, there are limits to which the airplane can be maneuvered before this stabilization is degraded. Ideally, the radar is designed such that these constraints are beyond the maneuvering limits of the host airplane for all three maneuvering axes (roll, pitch and yaw). Measuring yaw rates in flight without instrumentation is quite difficult, thus step inputs up to the maximum allowable at a mission relatable maneuvering speed will be used instead of an actual yaw rate measurement. The loss of stabilization usually manifests itself as a degradation of detection, tracking and the radar display in general. In a search mode this usually means target misses or strobing and false alarms on the display. It is important to evaluate whether the display is still usable for detection and tracking of the target airplane during mission relatable maneuvers. Combined roll, pitch and yaw maneuvers can have their own effects upon the display and as such should also be evaluated.

2.3.5.3. Instrumentation

Data cards and a stop watch are required for the test with an optional voice recorder.

2.3.5.4. Data Required

Record the time to go from 40° nose low to 40° nose high at a constant g rate, up to the g limit of the airplane. Record the time to roll 360° at increasing stick deflections. Estimate the percent of rudder pedal throw used to achieve increasing yaw rates. During all maneuvers, make qualitative comments on the effects that the maneuvers have upon the radar display and detection performance. Record the same qualitative comments during rolling push-overs and pull-ups. Record qualitative comments concerning the effects of the antenna stabilization limits (if any are found) during mission relatable maneuvers and while positioning for an attack. Record whether in STT or search mode for all tests.

2.3.5.5. Procedure

Position the target 10 to 15 nm ahead of the test airplane at the same heading and speed and 1,000 feet above the test airplane. Establish a normal search mode, single bar pattern and a medium to narrow scan angle limit to allow a frequent update of the scan volume during the maneuvers. Establish radar contact with the target. Maneuver to 50° nose low and establish a 2g pull-up to 50° nose high at a constant 2g rate. Mark the time while passing from 40° nose low to 40° nose high. Note any degradation in detection of the target during the maneuver and any degradation of the display. If the elevation angle limits are less than 50°, then a smaller maneuver will have to be performed to maintain contact with the target. Repeat the test at increasing g levels until degradation is noted or the g limit of the airplane is reached.

Turn to place the target 20° off of the nose. Roll the airplane 360° at 1/4 stick deflection, noting the time to complete the roll and any degradation in detection or the display. Repeat at 1/2, 3/4 and full stick deflection if airplane limits allow. With the target again on the nose, perform a step input of the rudder at 1/4 deflection. Note any degradation of detection or the display. Repeat at 1/2, 3/4 and full rudder deflection if the airplane's limits allow.

If no degradation is noted while performing the tests above, perform a series of rolling push-overs and pull-ups at increasing g rates until the limits of the airplane are reached. Again, look for degradation in detection or the radar display. Repeat all three portions of the test while tracking the target in STT mode. During mission relatable intercepts and attack maneuvers, note the effects upon tactics of the limits found above.

2.3.5.6. Data Analysis and Presentation

Divide the time to perform the pitch up maneuvers into the 80° covered to obtain the pitch rate. Divide the time to roll into 360° to get the average roll rate.

If no degradation is noted within the maneuvering limits of the airplane during the single axis or the multiple axis maneuvers, then the stabilization limits are probably satisfactory. If degradation is noted they should be related to the limits that this degradation imposes upon tactics. The amount of limitation depends upon the axis involved (a pitch axis limit of 2g on an 8g airplane would obviously be more serious than a yaw axis limit of 1/4 rudder deflection) and the level at which the degradation is noted. These limitations should be verified during mission relatable intercepts and attacks.

2.3.5.7. Data Cards

Sample data cards are provided as card 9.

CARD NUMBER ___ TIME PRIORITY L/M/H

AIR-TO-AIR ANTENNA STABILIZATION LIMITS

[JOIN THE TARGET 10-15 NM IN TRAIL WITH THE TARGET AT THE SAME SPEED AND HEADING AND 1,000 FEET ABOVE. ESTABLISH RADAR CONTACT IN SEARCH, SINGLE BAR AND A MEDIUM SCAN ANGLE LIMIT. PITCH DOWN TO 50° LOW AND PULL-UP AT 2G TO 50° NOSE HIGH. TIME 40° LOW TO 40° HIGH. NOTE ANY DEGRADATION. REPEAT AT INCREASING G RATES.]

MODE	TIME TO PITCH	G	DEGRADATION

[TURN TO PLACE THE TARGET 20° OFF OF THE NOSE. ROLL AT 1/4 STICK DEFLECTION. NOTE THE TIME TO ROLL 360° AND ANY DEGRADATION. REPEAT AT 1/2, 3/4, FULL DEFLECTION.]

MODE	TIME TO ROLL	G	DEGRADATION

Card 9: Air-to-Air Antenna Stabilization Limits Data Cards

AIR-TO-AIR ANTENNA STABILIZATION LIMITS

[TURN TO PLACE THE TARGET ON THE NOSE. PROVIDE A STEP INPUT OF RUDDER AT 1/4 DEFLECTION. NOTE ANY DEGRADATION AND REPEAT AT 1/2, 3/4 AND FULL DEFLECTION.]

MODE	RUDDER INPUT	DEGRADATION

[PERFORM EASY ROLLING PUSH-OVERS AND PULL-UPS NOTING ANY DEGRADATION. REPEAT AT INCREASING G LEVELS UNTIL DEGRADATION IS NOTED OR THE AIRPLANE LIMITS ARE REACHED.]

DESCRIBE THE MANEUVER (CONTROL DEFLECTIONS, G LEVELS ETC.):

MODE:

DEGRADATION:

[REPEAT WHILE TRACKING THE TARGET IN STT.]

[EVALUATE THE ANTENNA STABILIZATION LIMITS DURING MISSION RELATABLE INTERCEPTS AND ATTACK MANEUVERS.]

MODE:

TYPE OF MANEUVERS:

DEGRADATION:

Card 9: Air-to-Air Antenna Stabilization Limits Data Cards (Continued)